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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/871,463	05/31/2001	Charles R. Spinner III	01-P-002 (STMI01-00013)	9805
30425	7590	02/16/2005	EXAMINER	
STMICROELECTRONICS, INC. MAIL STATION 2346 1310 ELECTRONICS DRIVE CARROLLTON, TX 75006			WARREN, MATTHEW E	
			ART UNIT	PAPER NUMBER
			2815	

DATE MAILED: 02/16/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/871,463

Applicant(s)

SPINNER ET AL.

Examiner

Matthew E. Warren

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 November 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) 1-7 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 8-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

This Office Action is in response to the Amendment filed on November 29, 2004.

Election/Restrictions

Applicant's election with traverse of Group I, claims 8-20 in the reply filed on November 29, 2004 is acknowledged. The traversal is on the ground(s) that independent claim 8 does not require removal of any portion of the protective barrier layer, but instead reads on the structure prior to chemical mechanical polishing. This is not found persuasive because the examiner has shown that the inventions of Group I and II are distinct. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP 806.05(f)). In method claim 1, portions of the tungsten and barrier layers are removed by chemical mechanical polishing. In the restriction, the examiner stated that an alternate process of etching could be used instead of CMP to remove the layers. Therefore, a materially different process has been shown to form the invention of Group I. The requirement is still deemed proper and is therefore made FINAL.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

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A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 8 and 10-14 are rejected under 35 U.S.C. 102(b) as being anticipated by Zhao et al. (US 6,060,787).

In re claim 8, Zhao et al. shows (fig. 3A) a portion of an integrated circuit comprising: a dielectric layer (302) over a substrate, a conformal tungsten layer (306) over the dielectric layer and within openings within the dielectric layer. A protective barrier (307) of tungsten is formed over the tungsten layer and within the openings. The barrier layer comprises a material for which removal by chemical mechanical polishing is primarily mechanical because the tungsten barrier layer (307) resists attack by the polishing slurry (col. 6, lines 3-19). Although Zhao does not specifically call the protective tungsten layer (307) a barrier layer, however tungsten is well known to provide the barrier function according to the teachings of Horak et al. (col. 5, lines 34-52).

In re claim 10, Zhao et al. shows (fig. 3A) that the portions of the tungsten layer within the openings are thicker than the portions of the tungsten layer over the dielectric layer.

In re claims 11 and 12, Zhao et al. shows (fig. 3A) that the protective barrier layer (307) overlies the entire tungsten layer (306). Zhao et al. also shows (fig. 3B) that the protective barrier layer overlies portions of the tungsten layer within the openings but not portions of the tungsten layer over the dielectric layer.

In re claims 13 and 14, Zhao et al. discloses (col. 5, lines 20-24 and col. 5, lines 50-55) that the tungsten layer has thickness between 4500 and 8000 Angstroms and the protective barrier layer has a thickness between 100 and 800 Angstroms.

Claims 8-12, 14, 16-19 are rejected under 35 U.S.C. 102(b) as being anticipated by Suzuki et al. (US 6,054,383)

In re claim 8, Suzuki et al. shows (figs. 2B-2C) a portion of an integrated circuit comprising: a dielectric layer (4) over a substrate (1), a conformal tungsten layer (8) over the dielectric layer and within openings within the dielectric layer. A protective barrier (10a) of TiN is formed over the tungsten layer and within the openings. The barrier layer comprises a material for which removal by chemical mechanical polishing is primarily mechanical (col. 6, lines 59-65).

In re claim 10, Suzuki et al. shows (fig. 2B) that the portions of the tungsten layer within the openings are thicker than the portions of the tungsten layer over the dielectric layer because the portion in the hole consists of two layers of folded tungsten.

In re claims 11 and 12, Suzuki et al. shows (fig. 2B) that the protective barrier layer (10) overlies the entire tungsten layer (8). Suzuki et al. also shows in another embodiment (fig. 4D) that the protective barrier (11c) layer overlies portions of the tungsten layer (9c) within the openings but not portions of the tungsten layer over the dielectric layer.

In re claim 14 Suzuki et al. discloses (col. 6, lines 1-2) that the protective barrier layer has a thickness of 0.05 microns (500 Angstroms), which is between 100 and 800 Angstroms.

In re claim 16, Suzuki et al. shows (fig. 2C) a portion of an integrated circuit structure comprising: a dielectric layer (4) having an opening, tungsten (8a) within the opening, and a portion of a protective barrier layer (10a) over a central region of the tungsten and within the opening, but not over peripheral regions of the tungsten. The protective barrier layer has the property of a material for which removal of chemical mechanical polishing is primarily mechanical (col. 6, lines 59-65) .

In re claim 17, Suzuki et al. shows (fig. 2C) that an upper surface of the tungsten is exposed around a portion of the protective barrier layer.

In re claim 18, Suzuki et al. discloses (col. 5, lines 62-67) that the protective barrier layer is titanium or titanium nitride.

In re claim 19, Suzuki et al. shows (fig. 2C) that the tungsten and the portion of the protective barrier layer form an upper surface, which is planar with an upper surface of the dielectric layer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al. (US 6,060,787) as applied to claim 8 above, and further in view of Horak et al. (US 6,436,814 B1).

In re claim 9, Zhao et al. discloses that the protective barrier is a tungsten film but does not explicitly show that the barrier film is a titanium or titanium nitride. Horak et al. discloses (col. 5, lines 34-52) that titanium or titanium nitride is a suitable material for a barrier layer and is interchangeable with a tungsten layer. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the tungsten barrier layer of Zhao by substituting it with titanium because Horak teaches that titanium is a suitable barrier layer for a tungsten plug.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al. (US 6,060,787) as applied to claim 8 above, and further in view of Van Buskirk et al. (US 6,346,741 B1).

Zhao et al. shows all of the elements of the claims except the opening in the dielectric being sized to form a capacitive electrode from the tungsten within the opening. Van Buskirk et al. shows. (fig. 1H) shows a capacitor device comprising a tungsten electrode contact (18) and a tungsten top electrode (44) formed in dielectric layer (18 and 35) openings. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the tungsten interconnect of

Zhao by incorporating that interconnect as a capacitor electrode because Van Buskirk teaches that tungsten interconnects suitably function as capacitor electrodes.

Claims 13, 15, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Suzuki et al. (US 6,054,383) as applied to claims 8 and 16 above, and further in view of Van Buskirk et al. (US 6,346,741 B1).

In re claim 13, Suzuki et al. shows all of the elements of the claims except the tungsten layer having a thickness between 4500 and 8000 Angstroms. Although, Suzuki states that the thickness of the tungsten layer may be $1/5$ to $2/5$ the diameter of the contact hole to provide a satisfactory contact (col. 5, lines 47-54), Suzuki does not disclose the specific diameter of the hole. However, it would have been obvious to one of ordinary skill in the art to make the of the tungsten layer within the desired range, to provide satisfactory contact action. It has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. *In re Aller*, 105 USPQ 233.

In re claims 15 and 20, Suzuki et al. shows all of the elements of the claims except the opening in the dielectric being sized to form a capacitive electrode from the tungsten within the opening. Van Buskirk et al. shows. (fig. 1H) shows a capacitor device comprising a tungsten electrode contact (18) and a tungsten top electrode (44) formed in dielectric layer (18 and 35) openings. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the tungsten interconnect of Suzuki by incorporating that interconnect as a capacitor electrode

because Van Buskirk teaches that tungsten interconnects suitably function as capacitor electrodes.

Response to Arguments

Applicant's arguments with respect to claims 16-20 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's arguments filed with respect to the 102 rejection of claims 8-15 over Zhao et al. have been fully considered but they are not persuasive. The applicant primarily asserts that Zhao does not show all of the elements of the claims, specifically the limitation reciting the "protective barrier layer comprising a material for which removal by chemical mechanical polishing is primarily mechanical. The applicant further argues that since the protective barrier (307) of Zhao is tungsten, then removal by CMP is primarily chemical. However, as stated in the rejection above, Zhao states (col. 6, lines 20-28) that:

Slurry accumulation (not shown) in the deposition trench results in less and more uniform deterioration of the trench walls 314 than in the conventional case, due to the structure of the protective layer 307.

Furthermore, the lines cited in the applicant's arguments (Zhao et al., col. 6, lines 13-18) do not teach away from the invention or reinforce the applicant's notion that tungsten removal by CMP is primarily chemical. In fact Zhao reinforces the examiners assertion that tungsten removal by CMP is primarily mechanical because Zhao states in those cited lines that "...the fine grain size and equiaxed grain structure of this nucleation layer 307 make it more resistant and more uniform in response to slurry

attack than the underlying bulk tungsten layer 306.” From that passage, it can be determined that the nucleation layer 307 (which is also tungsten) is resistant to the slurry chemicals, thus making its removal primarily mechanical and NOT chemical. The tungsten nucleation layer 307 is therefore a protective barrier against removal by chemical mechanical polishing. For these reasons, Zhao shows all of the elements of the claims, the rejection is still proper, and this office action is final.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E. Warren whose telephone number is (571)

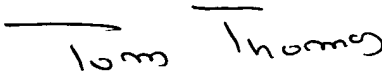
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272-1737. The examiner can normally be reached on Mon-Thur and alternating Fri 9:00-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571) 272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

MEW
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February 10, 2005.


TOM THOMAS
SUPERVISORY PATENT EXAMINER